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WATER CURRENT

NEBRASKA WATER CENTER
PART OF THE ROBERT B. DAUGHERTY WATER FOR FOOD GLOBAL INSTITUTE AT THE UNIVERSITY OF NEBRASKA

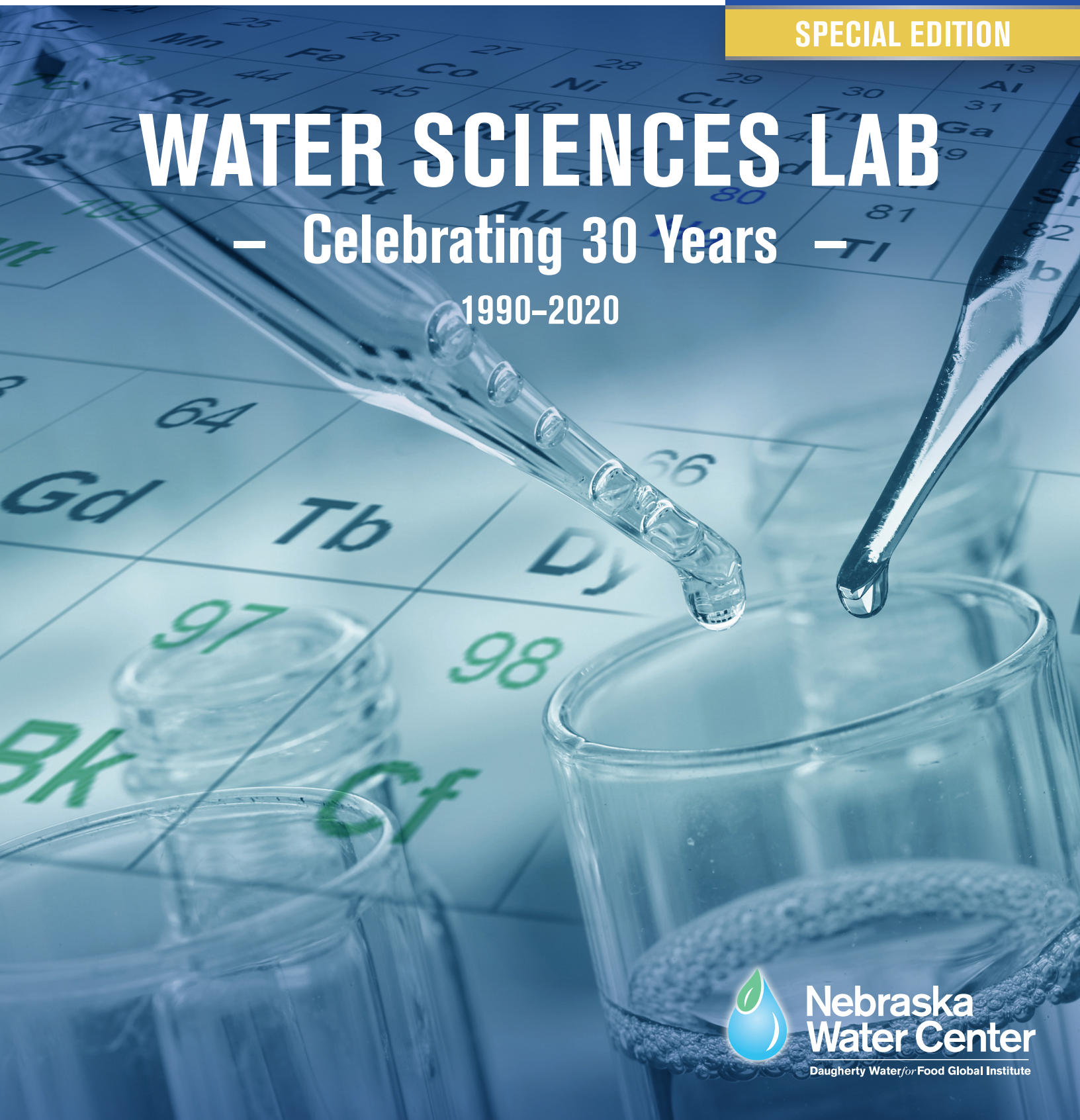
SUMMER 2020 VOL. 52, NO. 2

SPECIAL EDITION

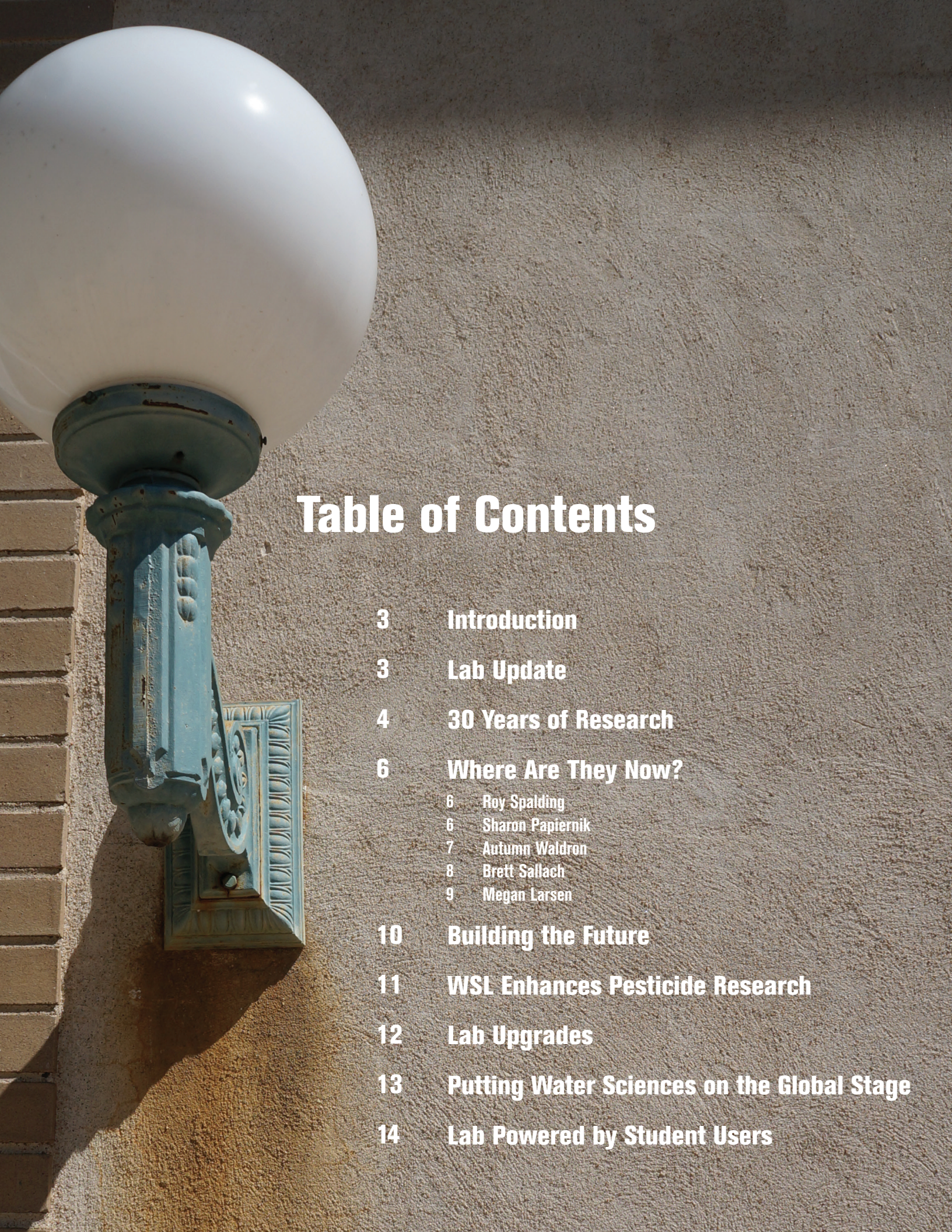
WATER SCIENCES LAB

– Celebrating 30 Years –

1990–2020



Nebraska Water Center
Daugherty Water for Food Global Institute



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From the Director

Chittaranjan Ray, Ph.D., P.E.

Director, Nebraska Water Center (NWC)

What a long and winding first half of 2020! The COVID-19 pandemic that began late last year has spread to every corner of the world, ours included. In mid-March, University of Nebraska staff, students and faculty transitioned to remote learning, teaching and working. The time since has been a journey of discovery. While many of our activities—like the 2020 Water & Natural Resources Tour and Nebraska Water Conference—were postponed to next year, I am grateful that we are all in good health and able to work from the safety of our basements, garages, bedrooms or whatever other makeshift offices we've invented.

This fall semester will be unlike anything any of us have experienced. As I reflect back on these first six months, I've been thinking about both the fragility and resilience of our species. It takes a lot to endure the many obstacles we face daily, and sometimes hourly. So I am proud that this special edition celebrates the 30th anniversary of the Water Sciences Laboratory (WSL). The lab's longevity and adaptability over three decades are noteworthy.

Moreover, I hope you enjoy reading about the history, people and technology behind the lab. We hear from people who've unknowingly walked right past its East Campus home—sometimes for years. Given the lab's unsuspecting exterior, I recall Han Solo admonishing Luke Skywalker in Star Wars, "She may not look like much, but she's got it where it counts, kid." You'll see what I mean throughout these pages.

Lastly, the WSL is always open to work with stakeholders across Nebraska and beyond. To learn more about the lab's services, check out its brand new brochure enclosed with this mailer.

Updates from the Water Sciences Lab

Saptashati Tania Biswas, Ph.D.

WSL Research Lab Manager

This year the Water Sciences Laboratory (WSL) celebrates its 30th anniversary. This is also an unprecedented year for the world due to the ongoing pandemic. The lab has shown great resilience and is continuing its critical mission of providing analytical services to water researchers and stakeholders.

Our service center was among the first to open after the COVID-19-related university-wide shut down late last semester. Soon after reopening, I wrote the WSL's COVID-19-related modified operational protocol in discussion with our laboratory staff, which was reviewed and approved by our Lab Director Dan Snow. The protocol includes requirements for COVID-19 awareness training, sanitization of shared objects and spaces, use of personal protective equipment (such as a face covering in common spaces), and maintaining more than 6 feet of distance in shared labs and offices. We have established a staggered schedule for lab staff and users to maintain a lower density at our facility and to facilitate social distancing guidelines. Our laboratory is at the forefront of the COVID-19-related mitigation plan that I recently submitted to our administration.

Our lab is adapting well to this evolving situation. We have established a contactless sample delivery system and our sample submission form and chain of custody can be completed and submitted electronically. All of our meetings are now conducted online through Zoom and day-to-day communication with lab users and staff are done on Slack, which is an online instant messaging system, in addition to regular emails. Kudos to all of our staff and lab users who are adapting to the modified operations and ensuring that our work and throughput is not compromised.

Our lab is working on a variety of projects. A lot of method development is going on with the newly purchased UHPLC-MS/MS system from Waters. We have several ongoing projects with Nebraska Lake Management, Natural Resources Districts (like Nemaha and Upper Big Blue), and Nebraska Game and Parks Commission, among others. We are excited to serve our faculty and resume student training for our graduate and undergraduate students. We warmly welcome them back for the upcoming fall semester. Our 30th anniversary is a productive year for the lab, as we all learn and grow in new ways. We are well positioned to lead the way for the next 30 years ahead.

Thirty Years on the Cutting Edge of University of Nebraska Research

By Kim Hachiya, Steve Ress and Jesse Starita, PR and Engagement Coordinator, NWC

Author's Note: This article is adapted from the Nebraska Water Center's 2015 Annual Report, where it first appeared. It has been updated to reflect the current state of the laboratory.

At its purest form, water is two parts hydrogen to one part oxygen. But water craves other elements and particles, which also are deeply attracted to water. Sometimes these chemical marriages are benign or beneficial, other times they can be problematic, even detrimental.

For 30 years, the University of Nebraska–Lincoln's Water Sciences Laboratory (WSL) has sussed out these chemical alliances—all the while establishing itself as one of the country's premiere laboratories in answering the question of "what's in the water?"

The lab was founded under the directorship of Dr. Roy Spalding in 1990 (see interview on p. 6), with funding from the Nebraska Research Initiative. This initiative was established by the Nebraska Legislature to promote research in critical areas. Since then, the 6,000 square-foot East Campus lab has become a university-designated "core research facility" owing to its work with researchers and scientists across disciplines, colleges and campuses.

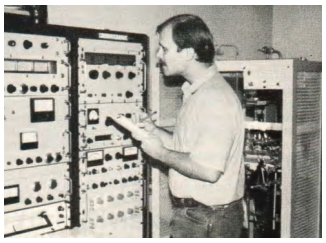
WSL scientists deliver technical services and expertise through its $3 million worth of cutting-edge instruments, delivering water analyses to a range of clients. That notion of "expertise" is the critical feature, said Dr. Chittaranjan Ray, who directs the University of Nebraska Water Center, of which the WSL is an indispensable part.

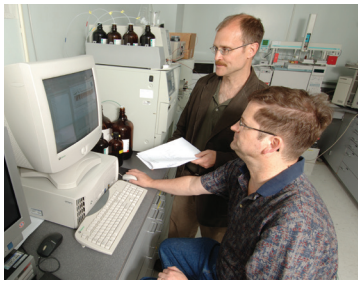
While the instruments—mass spectrometers, gas or liquid chromatography and other machines—run the samples, it's the design of the experiments, the creation of the processes that develop the samples, and the analysis of findings that differentiate this lab from others, Ray said.

"The human brain is more important than the machinery," Ray said. "The real difficulty is coming up with the methods of separating the samples and compounds; it's the design of the experiment, each of which is unique. In our lab, the scientists are also training students in the methodologies. And it's a beautiful collaboration with faculty and students that also builds the university's research capacity and portfolio."

"Of the 54 U.S. water centers," Ray stated, "just 14 have water sciences labs. Nebraska's is one of the biggest and best because of the chemists, interns, students and number of collaborators across so many disciplines."

WSL Director of Services Dan Snow has been affiliated since the beginning, when he was a geochemistry doctoral candidate. Snow's research contributed field and laboratory methods to the lab's first big project, the Management Systems Evaluation Area (MSEA).





1990 – Water Science Research Facility established with funding through the Nebraska Research Initiative. Facility later renamed Water Sciences Laboratory (WSL).

1991 – WSL begins groundwater quality and irrigation research at the Management Systems Evaluation Area (MSEA) near Shelton, NE.

1992 – High-sensitivity dual inlet stable isotope mass spectrometer and new GC-MS for pesticides are both added. Nebraska groundwater recharge projects supported.

1997 – First liquid chromatograph-mass spectrometer, or LC-MS, arrives with capability for "emerging contaminants" methods.

2002 – High-sensitivity triple quadrupole LC-MS for emerging contaminants and two additional stable isotope mass spectrometers added through EPA grant.

2003 – Daniel Snow takes over as WSL director.

The MSEA project produced thousands of groundwater samples from areas near Shelton—in the heart of the Platte River valley—to understand how different irrigation practices affected groundwater quality. These samples were processed and analyzed at the WSL.

Dozens of scientific papers followed. Many of these studies showed that water-conserving irrigation practices not only saved water, Snow said, but also improved groundwater quality without negatively affecting crop yields.

These and other projects exemplified what Snow calls applied science—looking for ways to control or minimize negative impacts for future water users. Three decades ago, the lab was testing mostly for the herbicide atrazine and for nitrates. Since then, instruments have become more sensitive and can test for myriad other contaminants at far smaller concentrations. As a result, today's lab offers over 140 analytical methods that allow its scientists to exploit a fuller range of the instruments' capabilities.

Many of these studies are done for state entities, like Nebraska's Natural Resource Districts (NRDs), who are charged with managing Nebraska's groundwater. "NRDs want to know where to best use their resources," Snow said, "so identifying the source of problems using the WSL helps them prioritize."

Snow and Ray said the lab contributes knowledge to the field of "emerging contaminants," which include algal toxins, explosives, petrochemicals, pharmaceuticals, polyfluoroalkyl substances, estrogens, antibiotics and illegal drugs. Lab scientists have also developed protocols to analyze for contaminants in foods and food components.

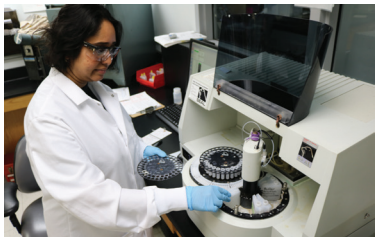
More recently, the lab began testing for neonicotinoids. Chemically similar to nicotine, these insecticides have controversial environmental impacts—particularly to the health of honeybees—and their use has grown considerably over the past several decades. With neonicotinoid residues entering surface and groundwater across the country, the lab teamed with UNL Water Quality Engineer Dr. Tiffany Messer to investigate where they are found, their potential impacts and what can be done to minimize these impacts. The laboratory has recently developed methods to measure these chemicals at very low concentrations in water and plant tissue samples (see related article on p. 11).

While the lab's core research funding originates from the Nebraska Research Initiative, this amount has decreased over time. This makes revenue from national grants like Messer's project even more significant. Additionally, NU colleges and institutes recently added internal support to facilities like the WSL that benefit from student training and researcher access (see student profiles on p. 14). In the decades to come, these internal sources will continue to play a role, but grants and external revenue—built on the lab's reputation as a state-of-the-art analytical and training laboratory—will likely play a larger role in financial support.

Thirty years in, the WSL is positioned for success in myriad ways: commercially, through a client matrix including local agencies, federal funders, state support, academia and private corporations; technically, via increasingly sophisticated instrumentation; and organizationally, through a thriving student internship program and new staff like Dr. Saptashati (Tania) Biswas, whose acumen as lab manager helped grow the lab's number of samples from 4,000 in 2015 to 11,000 in 2019.

Snow, a leader and observer of this lengthy transformation, has enjoyed being a witness to water's many chemical marriages.

"I get to dabble in a lot more interesting things than if I were in just one department. It's enjoyable to meet and work with so many different viewpoints over water."



2005 2010 2012 2013 2017 2018 2019 2020

2005 – WSL acquires new inductively coupled plasma mass spectrometer (ICP-MS) for uranium and arsenic research, and GC-MS system for volatile organics support.

2010 – Daugherty Water for Food Global Institute (DWFI) founded.

2012 – NWC and WSL become part of the DWFI; WSL funded for noble gas mass spectrometer age-dating system.

2013 – Chittaranjan Ray joins NWC as director.

2017 – Saptashati (Tania) Biswas joins as research lab manager.

2018 – New ICP-MS with As, Se speciation capability acquired.

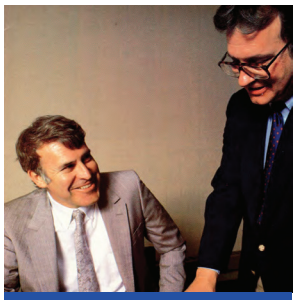
2019 – Lab is funded for state-of-the-art 2D UPLC-MS triple quadrupole MS and building undergoes significant renovation.

2020 – WSL celebrates 30th anniversary.

WHERE ARE THEY NOW?

Catching Up with Lab Alumni

As indispensable as analytical equipment is, people are the real fulcrum of the Water Sciences Laboratory. To acknowledge how individuals have contributed to the lab–and the lab's contributions to their growth–we assembled a *Where Are They Now?* series of interviews, profiles and photos. While the researchers profiled here span eras and expertise, genders and geographies, we hope you enjoy learning how the lab connects them as water science kin.



Drs. Roy Spalding (left) and NWC Interim Director Dale Vanderholm pictured here in 1990.
(Credit: Nebraska Alumnus)

Dr. Roy Spalding

Dr. Roy Spalding was, pardon the pun, instrumental in the establishment of the lab. As its founding director, Spalding helped get the lab up and running in the late 1980s and early 1990s. He retired from UNL's Department of Agronomy & Horticulture in 2013 after a 39-year tenure. We recently caught up with Dr. Spalding in Merritt Island, Florida, where he relocated for retirement.

NWC: What was your role in establishing the lab?

Roy Spalding: My role was to design a Water Sciences Laboratory and to bring in sizeable amounts of research funding. In order to become the director, numerous things had to fall in place. First, I had an offer for a job in another state and the offer was substantially higher than what I was making. Thus, (then NWC Director) Roger Gold and the IANR administration fought to keep me at UNL by adjusting my wage and directing me to design a water laboratory by renovating the old Wildlife Laboratory Building. Included in the deal were funds for moving and installing equipment that I had previously accumulated at the Conservation and Survey Division (CSD).

NWC: Why was the lab founded?

RS: The laboratory was founded specifically to determine the extent and sources of agricultural contamination in ground and surface water. This research was strongly aligned to my previous work at CSD.

NWC: What water issues in Nebraska were the lab seeking to address at that time?

RS: The main issue for the laboratory was controlling the leaching of agricultural chemicals to our water sources.

NWC: How did the lab contribute to scientific and public understanding of water quality issues?

RS: The laboratory was first to show in reports and peer-reviewed publications that nitrate in Nebraska's groundwater was primarily from fertilizer leachate. The laboratory was also first to report that atrazine and some other herbicides were present in groundwater.

NWC: How did the lab enable UNL researchers to perform advanced analyses?

RS: The laboratory contained a state-of-the-art isotope ratio mass spectrometer and a GC-mass spec for tracing herbicides by isotope dilution.

Dr. Sharon Papiernik

Dr. Sharon Papiernik (née Widmer)

Dr. Sharon Papiernik was among the first doctoral students to come through the lab in the early 1990s. Her dissertation broke new ground, literally and figuratively, on the fate and transport of pesticides in Nebraska's aquifers. We recently caught up with her in Brookings, South Dakota, where she works as a research leader at the USDA Agricultural Research Service's North Central Agricultural Research Laboratory.

> **"The problems we studied then are the problems we are addressing now, and I expect they will be the same problems we face in the future: Agriculture will need to use water with ever-increasing efficiency and with smaller impacts on water quality."**
>
> *– Dr. Sharon Papiernik*

NWC: Tell us about your role and responsibilities during your time at WSL?

Sharon Papiernik: I was a graduate student at the WSL from 1991 to 1995, with Dr. Roy Spalding as my Ph.D. advisor. My dissertation, "Measurements of Pesticide Mobility and Persistence in Groundwater," reported the results of field research conducted in Fremont, Nebraska. My experiments were the first large-scale in situ studies of pesticide transport in an aquifer that used concentrations representative of groundwater affected by nonpoint source contamination. These were also the first large-scale studies investigating the fate and transport of herbicide transformation products. Results showed that the studied herbicides were transported at nearly the same rate as groundwater and most compounds exhibited no degradation in two to three months. This research emphasized the importance of pollution prevention because of the potential for agrochemicals to spread and persist once they have leached to groundwater.

NWC: How did the lab help you cultivate your scientific and professional capabilities?

SP: The skills that I learned at the WSL were critical to my scientific career. I went from a B.A. in chemistry to a Ph.D. in soil and water science in four years—such things were possible in those days—so I had a steep learning curve. My undergraduate career had prepared me well, but at the WSL, I gained an appreciation of how research is planned, conducted, and reported in an academic setting. I learned technical aspects of research, like techniques to extract and analyze chemicals at low concentrations; organizational skills including prioritization and time management; and oral and written communication skills that prepared me for the next step in my career. I received much assistance from the WSL staff, but I think that expectations for independent progress helped prepare me for a successful scientific career.

NWC: What are you doing currently?

SP: I am currently Research Leader of the North Central Agricultural Research Laboratory in Brookings, South Dakota, which is part of the USDA-Agricultural Research Service. In my current position, I am a scientist and administrator, overseeing all aspects of the lab's daily operations and proper expenditure of its $3.3 million in federal funds. To this end, I work with my agency and stakeholders to determine research needs and priorities and supervise a group of eight scientists and over 20 support staff who conduct research to develop resilient and profitable cropping systems in the northern Great Plains. I provide scientific leadership to multidisciplinary teams investigating problems related to pest biology, crop management, development of integrated pest management (IPM) practices, conservation of soil resources and beneficial insects, and development of sustainable agricultural systems.

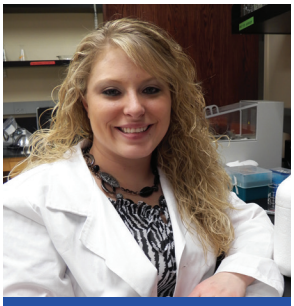
In addition to my administrative duties, I conduct individual and collaborative research. My research is focused on (a) evaluating the impact of land management on soil physical, chemical, and biological properties that impact soil productivity and environmental quality and (b) assessing the impact of soil properties and land management practices on agrochemical efficacy, degradation, and mobility.

NWC: As the lab looks forward to its next 30 years, what is your challenge to the lab?

SP: It seems incredible that almost 30 years have passed since I was a student at the WSL. The problems we studied then are the problems we are addressing now, and I expect they will be the same problems we face in the future: Agriculture will need to use water with ever-increasing efficiency and with smaller impacts on water quality. The specifics will change, the technology will change, the terminology we use will change. It is a challenge to retain expertise and capacity to meet current needs while adapting to address new developments. I trust the WSL is up to the challenge.

NWC: Anything else you'd like to share?

SP: Malnutrition is still the leading cause of death and disease in the world, and a major contributor to conflict worldwide. In the U.S.A., improved agricultural practices are needed to produce abundant food and fiber, restore productivity to degraded land, support rural economies, and more, with minimal adverse environmental consequences. The WSL is helping improve modern agriculture to simultaneously achieve many goals, and I am proud to be a product of the WSL. Best wishes to the WSL on its 30th anniversary!



Surrounded by beakers and flasks, Autumn Waldron is in her element at the WSL.

Autumn Waldron (née Longo)

Autumn Waldron played a key role in the laboratory's growth over the past half-dozen years. She recently transitioned from the lab into a position with the State of Nebraska as a chemist. Waldron still keeps a hand in the lab working part-time as needed.

NWC: Tell us about your role and responsibilities during your time at WSL?

Autumn Waldron: I was hired in 2014 as a Research Technologist I. My responsibilities started with operating the Inductively Coupled Plasma Mass Spectrometry (ICPMS) for metal analysis, performing all wet chemistry techniques on customer samples, and operating and maintaining all the instruments in Room 203 for nutrient chemical analysis. In 2015, my responsibilities grew and I was learning to analyze samples using the Liquid Chromatography Mass Spectrometry (LCMS) methods along with the Stable Isotope instruments methods to help with backlogged samples. With the extra responsibilities, I was promoted to Research Technologist II. I continued to take on responsibilities that included training most of the incoming students on basic laboratory skills, and checking in all the received samples.

NWC: How did the lab help you cultivate your scientific and professional capabilities?

AW: Working at WSL was my second professional position right after graduating with my bachelor's degree. I already had a strong background in analytical and instrumental chemistry from my academic research. However, working at the WSL helped me fine-tune my techniques and I learned so much from (WSL Director of Services) Dan and the others there regarding water and soil testing. This knowledge has been a crucial stepping-stone for me as a professional and has opened many doors.

NWC: What are you doing currently?

AW: I am a Chemist III-Lead Worker for the State of Nebraska Department of Agriculture Laboratories in Lincoln. We work with the Food and Drug Administration to test food products for chemical adulterants such as heavy metals, pesticides, poisons, and other toxins. We also work with local law enforcement on criminal cases for unknown analysis. I also still work part-time at WSL to help with sample overload and Standard Operating Procedures (SOP) writing.

NWC: As the lab looks forward to its next 30 years, what is your challenge to the lab?

AW: I have had the pleasure to see this lab grow over the last six years. They have become more involved with students and research along with keeping current on regulatory testing.

I challenge WSL to now become accredited by National Environmental Laboratory Accreditation Conference (NELAC). Accreditation would ensure the lab is a trusted source for sample analysis and would standardize most of the methods used with other environmental laboratories.

Dr. Brett Sallach

Drs. Brett Sallach, Yuping Zhang and Xu Li with lettuce grown for their USDA project researching recycled wastewater for vegetable irrigation. *(Credit: University Communication)*

Brett Sallach has come a long way since leaving the Water Sciences Laboratory five years ago—literally and figuratively. After earning his civil engineering Ph.D. from UNL in 2015, Sallach had a stint as a post-doc at Michigan State University and then ventured across the pond, where he is currently a lecturer at the University of York's Department of Environment and Geography.

Though far from the cozy confines of the WSL, he credits the lab with getting him to his current destination.

"I feel very fortunate for the opportunity to work at the lab," Sallach recalled.

The WSL provided a point of entry and independent learning of mass spectrometry.

"There's limited opportunity to really engage with mass spectrometry at the level needed for a novice to become an expert user. I had a rare opportunity," Sallach said.

Sallach came to the lab in 2010 as a student working on a USDA-National Institute of Food and Agriculture (NIFA) project led by UNL Civil and Environmental Engineering Professors Drs. Shannon Bartelt-Hunt (primary supervisor) and Xu Li, as well as WSL Director of Services Dr. Dan Snow and since retired Agronomy and Horticulture Professor Dr. Laurie Hodges. There, he researched how plants take up mixtures of both antibiotics and human pathogens, characterizing the potential risks of applying wastewater to irrigate vegetables.

So what's he been up to since leaving the lab?

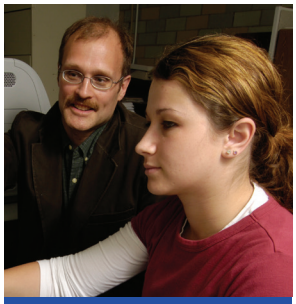
A fateful workshop in the final year of his Ph.D.—organized in part by Snow—connected Sallach with Professor Alistair Boxall of the University of York. From there, Boxall encouraged his successful application for the Marie Skłodowska-Curie Fellowship, a prestigious two-year award to promote scientific exchange to the European Union. After a short stint as a postdoc at Michigan State University, Sallach moved to York in the summer of 2017 as a research fellow and has only gone up. Last year, he took a lecturer position at the University of York (equivalent to assistant professor in the U.S.), where his research focuses on evaluating impacts of emerging contaminant exposure on soil health and crop productivity.

Raised in Charlotte, North Carolina, Sallach said attending UNL fulfilled a childhood dream. His parents are UNL alumni from Albion, Nebraska, and two of his sisters are current Nebraska residents. Of his work at the university with Snow, Li and Bartelt-Hunt—all with whom he maintains contact—Sallach says they answered some very relevant questions that are being used to protect the security of a susceptible food chain in response to a rapidly changing climate.

Speaking of relevant questions, we asked Sallach what the lab should instill in future generations of water scientists?

"Looking into the future," he said, "I think high resolution mass spec is rapidly improving and needs to be included in the WSL toolbox."

"It's complimentary to the targeted methods that the WSL is internationally known for."



As part of her first stint at the WSL in 2006, Larsen worked with WSL Director Dan Snow to analyze samples. *(Credit: Brett Hampton, University Communication)*

Dr. Megan Larsen

After her first sip at the Water Sciences Laboratory, Megan Larsen ordered a double shot.

In 2006, the then Nebraska Wesleyan University undergraduate joined the WSL as a summer intern. For three months, she sat in front of a "giant wall of glass," also known as the nitrogen isotope prep line to convert different types of nitrogen for other analyses. Though the work itself was repetitive, it provided a foundation in water quality topics and analysis that would later pay dividends. She graduated from Nebraska Wesleyan and then went on to get a Ph.D. in evolutionary biology at Indiana University.

"That one experience," Megan recalled of that summer, "set the stage for everything else that I did—not only as an undergrad, but also as a grad student and now as a Ph.D."

She would return to the lab a full decade later. While out for a stroll one day in mid-2016, Megan was pondering what about science made her excited. It turned out that cyanobacteria and toxins—a turnoff for many and serious threats to human and ecosystem health—did just the opposite to her.

So began her second stint at the WSL. Officially a short-term lab technician-manager, the position focused on "everything that (WSL Director) Dan wanted to do, but hadn't had the time to do." This laundry list included things like project management, running instruments, revising the lab's operation manual, website renovation and working up data from previous projects. She left the lab in 2017.

So what's she been up to the last few years? Lots.

In the fall of 2017, Megan started a post-doc at Wilfrid Laurier University in Waterloo, Ontario, funded through Canada's Global Water Futures initiative. This work has produced site-specific cyanobacterial analyses to inform water managers across the country. That led her to apply for the Mitacs Accelerate Fellowship—a unique award that brings together academics and industry to solve real-world challenges. As a current fellow, she is working with the Buffalo Pound Water Treatment Plant in—get ready for it—Moose Jaw, Saskatchewan. She is synthesizing and analyzing long-term operational and distribution data to help the utility understand and develop strategies for increasingly prevalent and intense cyanobacterial blooms.

[See sidebar on water treatment plant fellowship.]

To boot, Megan is also a data scientist with the Portland, Oregon, start-up DAPPER Stats and is planning a move to California later this year.

As the lab commemorates its first 30 years, we asked her what is one thing the WSL should emphasize to its next generation?

"There's a lot of value in training people how to collect good field samples and how to process those in a lab."

And, she says, the lab doesn't have to do all of this by itself:

"If they continue to pair up with other state agencies and other groups that are already doing sampling, there's no reason why we can't piggy back off of each other to spread the benefit and water knowledge gained by the lab."

Larsen Puts Lab Experience To Use In Field

Safe, secure, and reliable drinking water is critical to public health.

Most municipal drinking water is sourced from surface water (like lakes and reservoirs) and groundwater that may contain pathogenic microorganisms and/or chemical compounds that elevate health risks. For some water treatment facilities, climate change has exacerbated water quality challenges pushing them to develop new strategies and operations to meet their core mandate.

These facilities produce vast quantities of water quality data. Each metric is used to ensure the water treatment process is effective and that what comes out of the household tap is both reliable and safe.

Predicting how climate change and other impairments may influence future water quality requires the integration of information from the watershed to the tap.

Through a Mitacs fellowship, Dr. Megan Larsen has partnered with the Buffalo Pound Water Treatment Plant (BPWTP), based in Moose Jaw Saskatchewan (Canada), to do just that. BPWTP services more than 260,000 residents in the cities of Regina, Moose Jaw, and surrounding area. Source water for plant operations is taken from Buffalo Pound Lake, a shallow (~4m), well-mixed reservoir in south central Saskatchewan's Qu'Appelle Valley.

Larsen is leveraging her background in water quality, microbiology, and data science to integrate 50 years of historical watershed, treatment plant, and municipal water supplies to develop adaptive, data-driven operational plans and gather historical insights into water quality changes.

With collaboration from Wilfrid Laurier, the University of Saskatchewan, and the University of Montreal, Larsen is also taking a multifaceted research approach to understanding cyanobacteria bloom risks to drinking water treatment. These partnerships have yielded seasonal dynamics about the biological, physical, and chemical makeup of Buffalo Pound Lake, all of which will provide critical information for managing our water resources.

Building the Future of Nebraska's Water Management

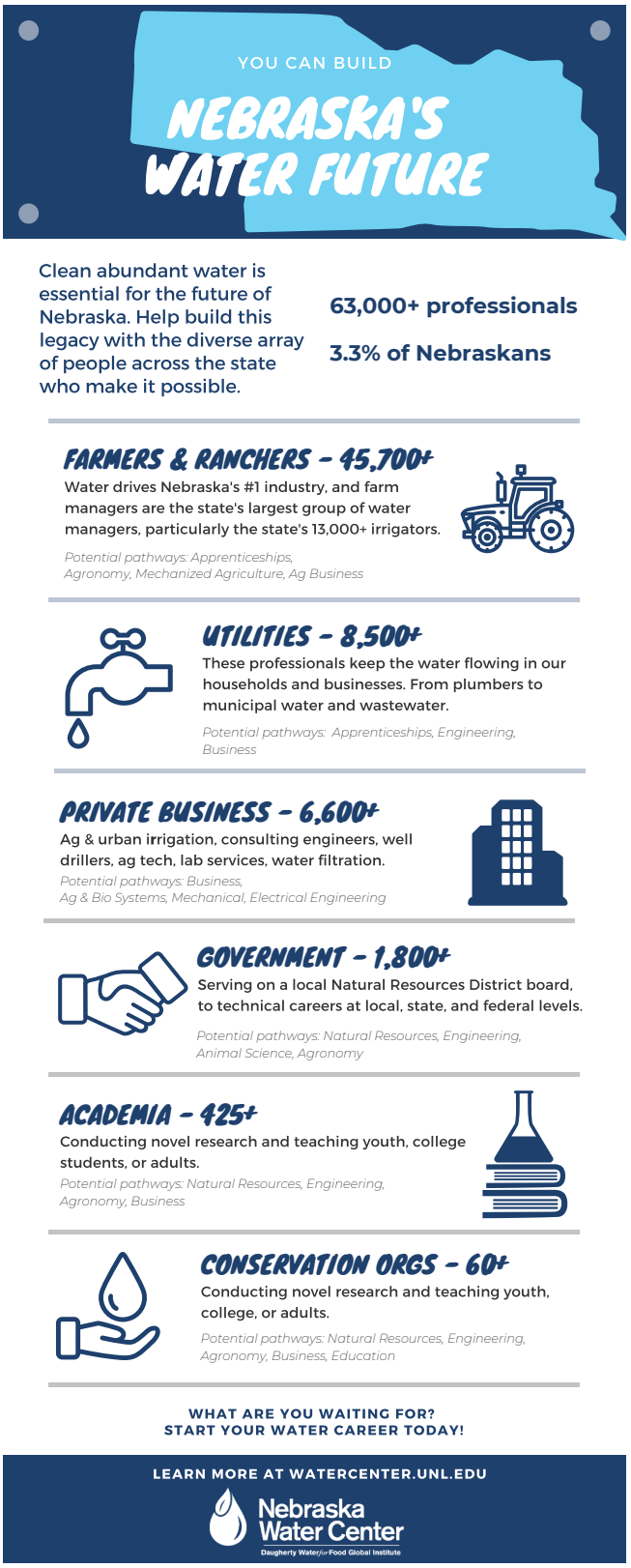
By Crystal A. Powers, Research and Extension Communication Specialist, NWC

Clean, abundant water is essential for the future of Nebraska and throughout the world. Universal access to clean water is one of the Sustainable Development Goals (SDGs) put forth by the United Nations. Here in Nebraska, we manage one of the world's largest irrigated agricultural regions, driving the economy and supporting communities. Water managers and professionals work tirelessly to ensure this clean, abundant supply into the future. Nebraska's higher education institutions are committed to helping prepare the world's future water professionals and what better living laboratory than Nebraska.

Amazingly, Nebraska has over 63,000 water professionals and managers! We created the adjacent infographic to explore these different roles. Water careers will continue to be in high demand. The U.S. Bureau of Labor Statistics predicts above average replacement needs across this sector, from plumbers to engineers.

We surveyed Nebraska's current water professionals about the skills new employees will need. Water is critical across several sectors, so a diversity of technical skills form the base: from laboratory, mechanical, engineering and computational, to agricultural, business and policy. Beyond these technical skills, there are basic skills that all employers would like to see: systems thinking, public engagement and project management. Systems thinking involves understanding the consequences of decisions: how decisions made in one part of a sector or business will impact the rest of the other parts. Public engagement is a suite of skills involving science communication by speaking and writing through traditional and new media. The third set of skills involves project management. These include teamwork, leadership and a basic understanding of project budgets and timelines. Together, these skills will prepare future employees to address water challenges on the horizon.

The final area to encourage growth in is diversity in water management. In Nebraska, less than 13% of our water leadership positions are held by women and even fewer by people of color. The Nebraska Water Center supports the University's commitment to cultivating an inclusive excellence mindset. We believe in fully embracing diversity in all forms seen and unseen, making inclusion a top priority, promoting equity across our policies and practices, and ultimately ensuring that excellence is inclusive. These perspectives will help us build a resilient water system for generations to come.



WSL Enhances Pesticide Research

By Jesse Starita, PR and Engagement Coordinator, NWC

Sprawling industrial farms and backyard gardeners alike use them. They are found in 120 countries and in 140 different crops. In short, they are the most widely used pesticides in the world: neonicotinoids.

Chemically similar to nicotine, neonics, as they're sometimes called, were developed commercially in the 1990s. Their neurotoxicity to insects and lower toxicity to birds and mammals helped fuel their widespread adoption. But as neonics were applied across continents and ecosystems, they also came under increasing scrutiny. According to Cornell University's Pollinator Network, this is due to their persistence in soils, ability to leach into the environment, high water solubility, and potential negative health implications for pollinators—in particular bees and Monarch butterflies. These pesticides have been linked to colony collapse disorder in honeybees, jeopardizing their ability to pollinate crops like almonds, apples, blueberries and cranberries.

You might be wondering what the Water Sciences Lab has to do with this? Well, there are many unknowns about how neonics interact with nature, particularly sunlight and water. To investigate these interactions, the lab is currently working with UNL Assistant Professor and Water Quality Engineer Dr. Tiffany Messer on the USDA-NIFA project "Photodegradation of Insecticides in Rivers Adjacent to Agricultural Intensive Regions: A Novel Water Quality Monitoring Approach." WSL Director of Services Dr. Dan Snow is a Co-PI.

The team is focusing on two rivers: the Elkhorn in Nebraska and the Neuse in North Carolina. According to Messer, the project examines two prevalent neonics—Imidacloprid and Clothianidin—on a microscopic level as they travel through a watershed.

"We're not just looking at the pesticide, but what it changes into and when it interacts with the natural environment. How does a particular particle move down the river and how often does it interact with sunlight?" she said.

With its high-powered analytical tools, the lab is running all of the project's pesticide samples. Instruments like the new Waters Xevo triple quadrupole mass spectrometer (see p. 12) is analyzing the pesticide byproducts produced by photodegradation, or the alteration of objects by light, on each particle collected.

"What we're looking for," Messer noted, "is where are the phototransforming hot spots in rivers, as the byproducts are often more toxic to nontarget species than the parent pesticide. Furthermore, identifying these hotspots can lead to designing effective best management practices to reduce pesticide impacts on water resources."

Ultimately, the lab can measure these chemicals in water and plant tissue samples at minute concentrations. A better understanding of these pesticides' fate and transport in waterways is important for food security, clean drinking water and public health.

Furthermore, the project furthers another important goal of the lab, student training. Messer's Ph.D. student Josephus Borsuah—a 2019-2020 Water for Food Global Institute Student Support Grantee—has learned how to prep samples in the lab. (Read more on Josephus on p. 14.)

The USDA-NIFA project runs through early 2022. In addition to Messer and Snow, Dr. Martin Doyle of Duke University rounds out the research team.

The impact on pollinators like honey bees is a cause for concern with the use of neonicotinoid pesticides. *(Credit: Smithsonian)*

Drs. Tiffany Messer and Dan Snow at UNL and Dr. Martin Doyle at Duke are working together to research neonics.

New Mass Spectrometer Part of Upgraded Water Sciences Lab

By Gabrielle Boucher, Undergraduate Student Intern, NWC

Author's Note: This article originally appeared in the fall 2019 edition of the Nebraska Water Current.

The Water Sciences Laboratory (WSL) on East Campus recently obtained funding for a new addition to its wide array of advanced analytical equipment. This new instrument, a Xevo TQS triple quadrupole mass spectrometer, is a major upgrade for the lab which has been using an older "triple quad" since 2002. This new machine will have state-of-the-art detection of chemicals, speed up processes and give researchers who use the lab an edge on research proposals and publications, which is one way it demonstrates competence and efficiency.

The Xevo TQS allows the lab capability to measure "emerging contaminants" at levels that previously could not be measured. Emerging contaminants, including new pesticides, pharmaceuticals, illicit drugs, veterinary and human antibiotics, steroids and flame retardants, can now be measured for research projects at higher precision and greater speed than ever before. Examples of emerging contaminants that can be measured with the Xevo TQS include polyfluoroalkyl substances, or "PFAS," which are highly complex and persistent. Methods for measuring these chemicals have only recently become available and these contaminants are being found in water supplies, soil, and plant and animal tissue. Being able to measure the PFAS can help to better understand their effects on human and ecosystem health. Director Daniel Snow notes the instrument is 1,000 times more sensitive than the older Quattro micro. The Xevo TQS also allows for less sample preparation and can rapidly switch between different detection modes, all of which speeds up the entire process. Pair that with the instrument being 10 times faster in analyzing a sample, the lab expects to make huge strides in emerging contaminants research.

Funding for the Xevo TQS was provided from a combination of sources, including a large portion from the Nebraska Research Initiative. The new equipment will be operated and maintained by Sathaporn (Tong) Onanong, who has developed a variety of methods for emerging contaminants since joining the WSL staff in 2008. Though the Xevo TQS requires extensive knowledge to operate properly, there are plenty of opportunities for students and researchers to be trained. Lab Research Manager Tania Biswas, has developed a suite of training modules for new users that includes basic safety training, lab methods training, and actual instrument proficiency training. Snow says the lab is always open to the possibility of training students and generally starts with sample extraction and purification. One use for the older Quattro mass spectrometer is to train others on how to properly use a triple quadrupole mass spectrometer. After mastering preparation and operation of the Quattro, students will be able to move on to use the new triple quadrupole.

Part of the Nebraska Water Center, the Water Sciences Laboratory will celebrate its 30th anniversary in 2020. The new equipment is an important part to upgrading the look and feel of the lab whose mission is to provide technology, expertise, services and training in advanced analytical science supporting today's water and natural resources students, researchers and stakeholders. Staff and student users are looking forward to sharing more of what they do with the community and promoting the laboratory through tours, and they expect to hold an open house next year to promote the new capability.

WSL Director of Services Daniel Snow with the new Mass Spectrometer in the Water Sciences Laboratory on East Campus.

WSL: Putting Water Sciences on the Global Stage

The lab may be based in Nebraska, but it has a global reach. WSL has established itself internationally through projects and partners representing five continents and 27 countries. Some countries send samples for analysis without setting foot inside the lab, while others send students and scholars for training and professional development. Check out the map to see the lab's globetrotting and test your geography.

Afghanistan
Burkina Faso
Brazil
Cambodia
Chile
China
Columbia
Egypt
Germany
India
Iran
Israel
Italy
Jordan
Kazakhstan
Kyrgyzstan
Lebanon
Nepal
Nigeria
Peru
Rwanda
Singapore
Sri Lanka
South Africa
Tanzania
Thailand
Uzbekistan

Lab Powered by Student Users

In just the past few years, over 60 undergraduate and graduate students–from across Nebraska and the world–received training at the WSL. It is an incubator of young water science talent. During an average week, the lab is teeming with instruments churning out analyses, new users, guest visitors and students. To better appreciate these young lab members, we asked a few about themselves and their experiences at the lab.

Name: Nasrin Naderi Beni
Hometown: Esfahan, Iran
Year in School: Third
Major and Degree: Ph.D. in Civil Engineering

My master's project was about calibrating Polar Organic Chemical Integrative Sampler (POCIS) samplers and using them to measure the concentration of antibiotics in surface water. Therefore, I had to extract the antibiotics from both water-based samples and the resins of POCIS samplers using the extraction techniques that I learned at WSL. Then, after extracting the compounds using solvents and blowing them using N2 gas, I had to seal the vials so that the lab technician could measure the concentration of each compound.

The best part of my lab experience was that all the staff were so nice, friendly and willing to help whenever I needed someone to answer my never-ending questions! Also, the other good thing about WSL is that everything was available, organized and all the staff were keeping the lab safe and clean.

Name: Josephus F. Borsuah
Hometown: Gohn, Sierra Leone
Year in School: Second
Major and Degree: Ph.D. Student in Natural Resource Sciences with Hydrological Science Specialization

My major duty at WSL is to extract both polar organic chemical integrative sampler (POCIS) and grab water samples to analyze for neonicotinoid class of insecticides for my dissertation.

The best lab experience gained so far at WSL is learning from lab staff, being able to prepare my own samples for analysis and getting trained on a few instruments as required for my project.

Name: Justin Donald Caniglia
Hometown: Omaha
Year in School: Graduate Student (First Year) (B.S. in Water Quality Science w/minor in Environmental Restoration Science, May 2020)
Major and Degree: M.S. in Natural Resource Sciences with specialization in Hydrological Sciences

In the lab, I held a variety of duties. I analyzed water and soil samples for clients while learning a variety of instrumentation, including Gas Chromatography Mass Spectrometry Spectrophotometer, Seal AQ2 Auto Analyzer, Atomic Absorption Spectroscopy, Gravimetric Analyses, among others. I also trained on the Conductivity Meter, Turbidity Meter and pH Meter. Beyond learning the ropes on lab instruments, I was able to clean glassware, change acid baths, enter results of samples into spreadsheets for clients and write and edit Standard Operating Procedure (SOP) documents.

The best part of my lab experience was being able to gain hands-on experiences in a lab and contribute to relevant scientific research. Also, being able to grow important life skills like independent and team work, leadership and time management.

Name: Christopher Olson
Hometown: Pacifica, California
Year in School: Summer 2020 Graduate
Major and Degree: M.S. in Natural Resources Sciences with a minor in STEM education

Although I had no lab duties, I heavily utilized and depended on the lab in research necessities for the project I was involved in. I was trained in a variety of analytical instruments and procedures to attain data results needed in my research. All the tests that had to be run on the great volume of samples that were needed for my research could not be done without the experience, techniques and equipment that the lab and its personnel offered. I've been exposed to how much goes into environmental laboratory practices and the necessities of such practices in society at large, from rural communities to urban cities. During my time utilizing the Water Sciences Laboratory, I grew to realize its holistic impacts such that the chemistry and its results that occur in such a laboratory are not confined to the field of chemistry alone, but has undeniable implications in public policy, social interactions, public understanding, economic growth/sustainability as well as environmental health.

The best part of my lab experience was working with the laboratory personnel to achieve results that will help improve humanity and the world.

Name: Nicole Schumacher
Hometown: Murphy, Texas
Year in School: Senior
Major and Degree: Biological Systems Engineering with an Emphasis in Environmental and Water Resources Engineering

As an intern, I have multiple tasks in the lab, so every day at work can look different. Each week we receive batch sheets with samples to run and what equipment to test them on. I usually run samples on the IC, AQ2, and just learned how to use the TOC. I also help the staff with sample preparation using the SPE line for numerous amounts of water and soil samples that come to the lab.

The best part about working at the Water Sciences Lab is learning new things. I get to work with a wide variety of equipment and learn different methods, which helps me improve my lab skills every day.

Name: Serena Tenhumberg
Hometown: Lincoln
Year in School: Junior
Major and Degree: B.S. in Chemical Engineering

I operate technical equipment such as the Ion Chromatograph (IC), Inductively Coupled Mass Spectrometer (IC-PMS), Atomic Absorption (AA) Spectroscopy, and UV Vis Spectrophotometer to measure contaminants in water or soil. Most recently, I worked with another intern implementing the UV Vis Spectrophotometer method based on scientific papers that we read. I had to calculate proper concentrations for the standard curve range and perform experiments on accuracy and precision.

I enjoyed working with these instruments because I got to see the process for detecting trace amounts of compounds within a liquid or soil which is an important part of pollution detection.

Name: Surabhi Vakil
Hometown: New Delhi
Year in School: Fourth
Major and Degree: Ph.D. in Entomology

My duties were to review available literature and come up with potential feasible methods to analyze the samples. Help with the initial method development and once the method is developed help in sample preparation.

My whole lab journey was terrific. My trainings started from the fundamental skills such as pipette calibration, learning laboratory ethics and good lab practices, and gradually moving to an intricate part of the tasks such as neonicotinoid residue analysis. I learned a lot, and it helped me in boosting my confidence in pesticide residue analysis field. The matrix with which I was analyzing was challenging to work with and I was facing difficulty in finding labs that could analyze these samples. Drs. Dan Snow and Tania Biswas were excited to work on this new matrix and we were finally able to develop a method to analyze my samples. We are currently working on the manuscript to publish this method. Another plus point was our sample processing cost was reduced to half as I did the sample preparation part.

I want to acknowledge Victoria Wickham for being patient and explaining each process multiple times. It was a great experience and I encourage other students and collaborators to work in/with this lab.

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